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Mantle heterogeneity and dynamic processes beneath the super-segment of the Australian-Antarctic Ridge

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A 300-km-long super-segment of the Australian-Antarctic Ridge (AAR), which is bounded by two large-offset transform faults and has an intermediate spreading rate (70 mm/yr) and relatively shallow axial depth (~2,000 m), constrain diverse models of ocean ridge segmentation and melting processes. This super-segment has only small offsets along its entire length, but on the basis of undulating depth variations can be divided into three second-order segments, west, central, and east, with very different morphologies. The western second-order segment has a well-developed axial high. The central segment is a plateau with a small rift valley typical of intermediate spreading ridges and intersects a small seamount chain. The eastern segment is developing into a pronounced axial valley as depth drops by 1000 m upon approaching the transform. MgO contents of the glassy, sparsely phyric basalts (7-8.5 wt.%) are typical of intermediate spreading ridges, except for some highly differentiated samples at the western transform boundary, and one sample from the central segment. There are large and well-correlated variations between trace element ratios, such as La/Sm, and Sr-Nd-Pb-Hf isotopes along strike. Variations in axial morphology and depth correspond well with trace element and isotope variations, suggesting mantle composition is influencing ridge morphology in this region. A few samples with enriched isotopic compositions, but depleted La/Sm, indicate very recent trace element fractionation. Large isotopic variations are preserved even within the second-order segments, showing limited lateral transport and no significant effects of magma chamber homogenization along strike. On a remarkably fine scale, mantle heterogeneity and recent dynamic processes beneath the super-segment have strongly influenced both geochemistry and ridge morphology of the super-segment, showing an important influence of mantle heterogeneity for magma production and ridge morphology.